REMARKS

In response to the Office Action dated July 3, 2002, claims 1, 2 and 4-20 are amended, claim 3 is canceled, and claims 21-26 are added. No new matter has been added. Claims 1, 2 and 4-26 are now active in this application.

ALLOWABLE CLAIMS

The indication that claims 3, 4, 6, 7, 13, 14, and 19 would be allowable if rewritten in independent form, including all of the limitations of the base claim and any intervening claims, is acknowledged and appreciated.

Applicants note that claims 3 and 4 depend from claim 1 via claim 2, and that claims 6 and 7 depend from claim 1 via claim 5. However, Applicants believe it is clear that the limitations recited in claims 1+3 and 1+4 are patentable over the applied prior art references without the limitations recited in claim 2, and that the limitations recited in claims 1+6 and 1+7 are patentable over the applied prior art references without the limitations recited in claim 5.

Consequently, claim 1 is amended to include the limitations of claim 3, now canceled, claims 4, 6, 7, 13 and 14 are amended to be in independent form including the limitations of claim 1, claim 5 is amended to depend from amended claim 6, and claims 9-12 and 15 are amended to depend from amended claim 4.

In addition, claim 16 is amended to include the limitation of claim 3, claim 19 is amended to be in independent form including the limitations of claim 16, and new claims 21-26 are submitted. Claims 21 and 22 are discussed below. Claim 23 corresponds to original claim 5 and depends from amended claim 7, and claim 24 corresponds to original 2 and depends from amended claim 4. Independent claim 25 includes the limitations of original claims 16 and 4, and independent claim 26 includes the limitations of original claims 16 and 7.

Finally, claim 17 is amended to depend from new claim 25, while claim 18 is amended to depend from new claim 26.

It is believed that amended independent claims 1, 4, 6, 7, 13, 14, 16, 19, 22, 25 and 26 as well as dependent claims 2, 5, 8-12, 15, 17, 18, 20, 23 and 24, are allowable, and indication of which is respectfully solicited. Please note that amended independent claim 16, and new independent claims 25 and 26 are believed to be allowable for reasons similar to why claims 1+3, 1+4 and 1+7 are allowable, but with claim 1 replaced by claim 16.

REJECTION OF CLAIMS UNDER 35 U.S.C. § 103

I. Claims 1, 8-11, 15, 16 and 20 are rejected under 35 U.S.C. §103(A) as being unpatentable over Nakayama et al. (hereinafter, Nakayama) in view of Takasaki et al. (hereinafter, Takasaki). The Examiner admits that Nakayama does not disclose silicon as a multiplication layer and inhibiting layers. The Examiner maintains that Takasaki teaches silicon as a multiplication layer and inhibiting layers, and asserts that it would have been obvious to a person of ordinary skill in the art to modify the device of Nakayama with the multiplication layer and inhibiting layers of Takasaki to have low dark current as taught by Takasaki.

However, the amendments to claims 1, 4, 15 and 16 are believed to result in claims 1, 8-11, 15, 16 and 20, as amended, being allowable.

II. In an embodiment of the present invention, the conversion device includes a substrate, a hole injection inhibiting layer formed on only the substrate, a carrier generation/multiplication layer formed on the hole injection inhibiting layer, and an electron injection inhibiting layer formed on the carrier generation/multiplication layer. In contrast, the device of Nakayama has

an electrode formed on the substrate and a blocking layer is formed on the electrode. There is no disclosure or suggestion that the blocking layer is formed on only the substrate.

New independent claims 21 and 22 are submitted and are respectively derived from claims 1 and 16. However, both claims 21 and 22 delineate a substrate, a hole injection inhibiting layer formed on only the substrate, a carrier generation/multiplication layer formed on the hole injection inhibiting layer, and an electron injection inhibiting layer formed on the carrier generation/multiplication layer.

As this relationship is not disclosed or suggested in the applied prior art references, new independent claims 21 and 22 are patentable over the applied prior art references and their allowance is respectfully solicited.

CONCLUSION

Accordingly, it is urged that the application, as now amended, is in condition for allowance, an indication of which is respectfully solicited. If there are any outstanding issues that might be resolved by an interview or an Examiner's amendment, Examiner is requested to call Applicants' attorney at the telephone number shown below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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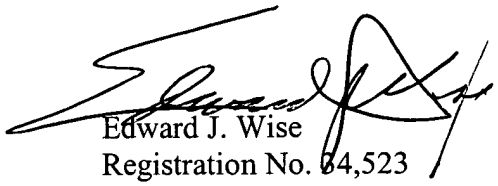

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VERSION WITH MARKINGS SHOWING CHANGES MADE

Please amend claims 1, 2 and 4-20 as follows:

1. (Amended) A photoelectric conversion device having a layered structure, said layered structure comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

an energy level at an interface between said amorphous silicon carbide layer and said amorphous silicon layer is discontinued on a conduction band side and equal on a valence band side.

2. (Amended) [A] The photoelectric conversion device as claimed in claim 1, wherein a composition ratio C/Si of said electron injection inhibiting layer is adjusted appropriately to 1.5 or lower.

4. (Amended) A photoelectric conversion device [as claim 2] having a layered structure, said layered structure comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

said carrier generation/multiplication layer is prevented from holes flowing out thereof, and is prevented from electron injection thereto.

5. (Amended) [A] The photoelectric conversion device as claimed in claim 6, [1,] wherein a composition ratio N/Si of said hole injection inhibiting layer is adjusted appropriately to 0.8 or lower.

6. (Amended) A photoelectric conversion device [as claim 5] having a layered structure, said layered structure comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

an energy level at an interface between said amorphous silicon nitride layer and said amorphous silicon layer is discontinued on a valance band side and equal on a conduction band side.

7. (Amended) A photoelectric conversion device [as claim 5] having a layered structure, said layered structure comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

said carrier generation /multiplication layer is prevented from electron flowing out thereof, and is prevented from hole injection thereto.

8. (Amended) [A] The photoelectric conversion device as claimed in claim 1, wherein said layer structure is formed on a surface of a substrate having at least said surface composed of polycrystalline silicon.

9. (Amended) [A] The photoelectric conversion device as claimed in claim 4, [1,] wherein said layer structure is formed on a surface of a substrate having at least said surface composed of microcrystalline silicon.

10. (Amended) [A] The photoelectric conversion device as claimed in claim 4, [1,] wherein said layer structure is formed on a surface of a substrate having at least said surface composed of monocrystalline silicon.

11. (Amended) [A] The photoelectric conversion device as claimed in claim 4, [1,] wherein said layer structure is formed on a surface of a substrate having at least said surface composed of a metal.

12. (Amended) [A] The photoelectric conversion device as claimed in claim 4, [1,] wherein a small amount of boron is introduced into said carrier generation/multiplication layer.

13. (Amended) A photoelectric conversion device [as claimed in claim 1] having a layered structure, said layered structure comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

said layer structure further comprises an electric field reducing layer for reducing an electric field adjacent an interface between said carrier generation/multiplication layer and said electron injection inhibiting layer.

14. (Amended) A photoelectric conversion device [as claimed in claim 1] having a layered structure, said layered structure comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

said layer structure further comprises an electric field reducing layer for reducing an electric field adjacent an interface between said carrier generation/multiplication layer and said hole injection inhibiting layer.

15. (Amended) [A] The photoelectric conversion device as claimed in claim 4, [1,] wherein said layer structure [consisting] consists of said carrier generation/multiplication layer, said [an] electron injection inhibiting layer, and said hole injection inhibiting layer.

16. (Amended) A solid-state image sensing device comprising:

a plurality of photoelectric conversion units, each [of which comprising] photoelectric conversion unit having a layered structure and including:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and the function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer; and

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer, and

an energy level at an interface between said amorphous silicon carbide layer and said amorphous silicon layer is discontinued on a conduction band side and equal on a valence band side;

a plurality of accumulation units for respectively accumulating charges generated by said photoelectric conversion units; and

an output unit for outputting the charges accumulated in said accumulation units.

17. (Amended) [A photoelectric conversion] The solid-state image sensing device as claimed in claim 25, [16,] wherein a composition ratio C/Si of said electron injection inhibiting layer is adjusted appropriately to 1.5 or lower.

18. (Amended) [A photoelectric conversion] The solid-state image sensing device as claimed in claim 26, [16,] wherein a composition ration N/Si of said hole injection inhibiting layer is adjusted appropriately to 0.8 or lower.

19. (Amended) A [photoelectric conversion device as claimed in claim 16, wherein said layer structure further comprises] solid-state image sensing device comprising:

a plurality of photoelectric conversion units, each of which comprising:

a carrier generation/multiplication layer composed of amorphous silicon to have both the function of absorbing light and generating carriers through optical excitation and function of multiplying the generated carriers;

an electron injection inhibiting layer composed of an amorphous silicon carbide of the p-type conductivity to inhibit injection of electrons into the carrier generation/multiplication layer;

a hole injection inhibiting layer composed of amorphous silicon nitride of the n-type conductivity to inhibit injection of holes into the carrier generation/multiplication layer; and

an electric field reducing layer for reducing an electric field adjacent an interface between said carrier generation/multiplication layer and said hole injection inhibiting layer, wherein

said carrier generation/multiplication layer is provided between said electron injection inhibiting layer and said hole injection inhibiting layer;

a plurality of accumulation units for respectively accumulating charges generated by said photoelectric conversion units; and

an output unit for outputting the charges accumulated in said accumulation units.

20. (Amended) [A photoelectric conversion] The solid-state image sensing as claimed in claim 16, wherein said layer structure [consisting] consists of said carrier generation/multiplication layer, said [an] electron injection inhibiting layer, and said hole injection inhibiting layer.